The Computer Science
Instructional Laboratory

## Introduction

Latex is a professional-quality typesetting program, written by the legendary Donald Knuth. Latex is portable, light, secure, and free. Latex is smart by default, but also allows for fine control of all aspects of your document.

## Parts of the Latex Source Code

A Latex document has two main parts: the preamble and the body.

### Preamble

The preamble is at the beginning of the Latex file and includes commands that will effect how your content is displayed.

The first line of your LaTeX document will be the `\documentclass` command, followed by a list of options and the name of a style. A standard example is

`\documentclass[12pt]{article}`

Between the curly brackets, put your document class. Your choices are `article`, `report`, `book`, `letter`. Between the square brackets, put options, separated by commas. With the options, you can control things such as font size, paper size, and paper orientation. Here are the default options for the article document class:

| Category | Default | Other Options |
|---|---|---|
| Body Text Point Size | 10pt | • 11pt<br>• 12pt |
| Paper Size | 8.5x11 (use `letterpaper`) | • `a4paper`<br>• `a5paper`<br>• `b5paper`<br>• `legalpaper`<br>• `executive paper` |
| Orientation | `portrait` | `landscape` |
| Print Side | `oneside` | duplex (use `twoside`) |
| Title Page | `notitlepage` | Title Page (use `titlepage`) |
| Columns | `onecolumn` | `twocolumn` |
| Display Equations | Centered | Flush Left (use `fleqn`) |

## More About Packages

Because Latex is so lightweight, many options and functions are not included by default (for example, mathematical fonts). You can tell your Latex document to include special functionality by including packages.

After the `\documentclass` command, you can include some packages with the `\usepackage` command, followed by the name of your package in curly brackets. For instance, use `\usepackage{amssymb}` for the AMS math symbols.

Most packages you will use are already installed on the computers in the lab (but you still have to use the `\usepackage` command in order to apply them to your document). If you need a package that is not already installed, download the appropriate `.sty` file and put it where Latex can "find" it (a good place is your working directory).

Download packages from `http://ctan.org`.

Some common packages you might want to use:

| Package | Uses |
| --- | --- |
| color | Change the color of your text. |
| graphics | Include graphics. |
| fullpage | Have smaller margins (default margins are large). |
| setspace | Switch between single, double, and 1.5 spacing. |

## Body

Put your content that you want to typeset between `\begin{document}` and `\end{document}` tags.

Most things that you type in the body of your document are typeset and show up in your final output document. Some exceptions: commands, spacing, special characters, comments.

## Commands

Commands alter the formatting of your text in the final output document. They are preceded by a single backslash. Some commands take arguments in curly brackets. We will discuss specific commands later.

## Spacing

Spacing in your LaTeX source code does not correspond to spacing in the typeset final product. For instance, if you see something like this in your text editor:

```
The          quick     brown
fox     jumped               over
the lazy          dog
```

the typeset version in your final output document will look like this:

The quick brown fox jumped over the lazy dog.

For a paragraph break, use: a line or more of blank space in your source code.

For a line break, use: \\ (this will give you a blank line in between two chunks of text)

For a page break, put \newpage.

To skip space vertically, use: \smallskip , \medskip, \bigskip, or \vspace{length}. Replace length with a unit of measurement (see table below).

To skip a space horizontally, use \thinspace (which inserts $\frac{1}{12}$ em of blank space), \enspace (which inserts $\frac{1}{2}$ em), \quad (which inserts 1 em), or \hspace{length} (which inserts as much blank space as you specify). In math mode, you can also use \; and \,.

## Units of Measurement

| latex name | long name | conversion |
| --- | --- | --- |
| pt | point | 72.27pt = 1in |
| in | inch | 1in = 25.4mm |
| mm | millimeter | 1mm = 2.845pt |
| cm | centimeter | 1cm = 10mm |
| ex | height of the letter x in the the current font | |
| em | width of the letter M in the current font | |
| sp | scaled point | 1sp = 65536pt |
| bp | big point (PostScript point) | 72bp = 1in |
| dd | didot point | 1dd = 0.376mm |
| pc | pica | 1pc = 12pt |
| cc | cicero | 1cc = 12dd |
| mu | math unit | 18mu = 1em |

## Special Characters

Some special characters are reserved by Latex , and must be preceded by a backslash if you want them to show up in your document: &, $, #, %, ^, {, and }.

The backslash is also a special character, and you have to type \backslash to get one to appear in your document.

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## Comments

Every line preceded by a % sign is a comment and will not show up in your typeset document.

Comments are good for writing little notes or explanations within your Latex file---good if you want someone else to read and understand the organization of your source code, or if you want to remember it yourself. Comments are also useful when writing papers; if you want to take out a paragraph but don't want to delete it entirely, just comment it out.

# Maths

## Environments

You can include math in-line ("math mode"), centered on a line by itself ("math display mode"), or centered on a new line with numbered equations ("equation mode").

### Math Mode

To include math in-line, surround the math with dollar-signs as delimiters. For example:

```
$\exp(x) = \sum_{n = 0}^{\infty}\frac{x^n}{n!}
         = \lim_{n \rightarrow \infty} \left( 1 + \frac{x}{n}\right)^n$
```

This is the result: $\exp(x) = \sum_{n=0}^{\infty} \frac{x^n}{n!} = \lim_{n\to\infty} \left(1 + \frac{x}{n}\right)^n$ It shows up in-line with the rest of your text.

### Math Display Mode

To put the math on a separate line, larger, and centered, use double dollar-signs as delimiters. This is the result of typesetting the same code as above(but with different delimiters):

$$\exp(x) = \sum_{n=0}^{\infty} \frac{x^n}{n!} = \lim_{n\to\infty} \left(1 + \frac{x}{n}\right)^n$$

Notice how the sum and limit behave differently.

### Equation Mode

To display one-line equations that will be numbered automatically, surround your math code by \begin{equation} and \end{equation}.

You will get the following result:

$$exp(x) = \sum_{n=0}^{\infty} \frac{x^n}{n!}$$

If you use equation mode again later in your paper, it will pick up the numbering where it left off:

$$exp(x) = \lim_{n\to\infty} \left(1 + \frac{x}{n}\right)^n$$

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## Math on Multiple Lines

For multi-line equations, use \begin{align} and \end{align}. In order to use this tag, you need to include the amsmath package. The following code

\begin{align}

\exp(x) & = \sum_{n = 0}^{\infty}\frac{x^n}{n!} \\

& = \lim_{n \rightarrow \infty} \left( 1 + \frac{x}{n}\right)^n

\end{align}

Produces this output:

$$\exp(x) \quad = \sum_{n=0}^{\infty} \frac{x^n}{n!}$$
$$= \lim_{n \to \infty} \left(1 + \frac{x}{n}\right)^n$$

Use & signs where you want your math to line up in a column. You can include as many &s as you want, but be sure to use the same number on each line. Also notice that align automatically numbers lines. For un-numbered lines, use align* instead.

## Special Characters

Special mathy characters are inserted with a backslash and the name of the character. For instance, $\Omega$, $\alpha$ produces: $\Omega$, $\alpha$.

For a comprehensive list of special characters, consult symbols-letters.pdf (which you can find at http://www.ctan.org/tex-archive/info/symbols/comprehensive/symbols-letter.pdf). This document lists all the special symbols you could want, and the packages in which they are included.

## Superscripts and Subscripts

Use the ^ and _ characters.

In-line, $x_i^y$ produces $x_i^y$. If you want to force the super- and sub-scripts into the height of one line, use $x{}_i^y$ to get $x{}_i^y$. You can also nest super- and sub-scripts by using curly brackets. For instance, $x_{i_j}^{y_k^r}$ produces $x_{i_j}^{y_k^r}$.

As you saw above, in math display mode $$, the super- and sub-scripts spread out in relationship to the main character when you're working with sums, products, integrals, and limits. If you want to force this positioning within a single line, use $\sum\limits_{i=1}^N$ to get $\sum\limits_{i=1}^N$ .

## Delimeters

| code | produces |
| --- | --- |

| | |
|---|---|
| `( )` | ( ) |
| `[ ]` | [] |
| `\{ \}` | {} |
| `$\langle \rangle$` | ⟨⟩ |

Latex will size your delimiters for you, so `$\left( x \left( \frac{\left( y + z \right)}{2z} \right) \right)$` produces $\left( x \left( \frac{(y+z)}{2z} \right) \right)$.

## Putting Things on Top of Other Things

| Thing | Code | Result |
|---|---|---|
| Roots | `$\sqrt{4} + \sqrt[3]{x + y}$` | $\sqrt{4} + \sqrt[3]{x + y}$ |
| Fractions | `$\frac{1}{x+y}$` | $\frac{1}{x+y}$ |
| Choose | `$x \choose y$` | $\binom{x}{y}$ |
| Atop | `$x \atop y$` | `$x \atop y$` |

## Tables

Sample code:

```
\begin{tabular}{ c | c c c }

& col1 & col2 & col3 \\

\hline
row1 & 11 & 12 & 13\\

row2 & 21 & 22 & 23\\

$\vdots$ & & & $\ddots$ & \\

row n & n1 & $\cdots$ & n3
\end{tabular}
```

Resulting Table:

| | col1 | col2 | col3 |
|---|---|---|---|
| row1 | 11 | 12 | 13 |
| row2 | 21 | 22 | 23 |

$\vdots$          $\ddots$

row n    n1    $\cdots$      n3

Edit the arguments in the second set of curly brackets like so: each letter (l, c, or r) denotes a column aligned left, center, or right (respectively). A pipe (|) between columns creates a vertical line between them.

Within the body of your table, separate columns with &, and end a row with \\. To include a horizontal line between rows, use \hline.

## Lists

### enumerate

Enumerate is numbered automatically, and you can nest enumerated lists up to four times.

You can change the character sets Latex uses to enumerate by including the following code in your preface: \renewcommand{\labelenumii}{\alph{enumi}}. Replace enumi with enumii for the second level, enumiii for the third, and enumiv for the fourth. Here, \alph produces lower-case letters; replace it with \Alph for upper-case, \arabic for regular numerals, \Roman for big Roman numerals, and \roman for little Roman numerals.

Here is an example of enumerate at work in its default way:

```
\begin{enumerate}
  \item first thing.
     \begin{enumerate}
       \item another thing.
         \begin{enumerate}
           \item nesting.
         \end{enumerate}
       \item don't forget to end the nests, though.
     \end{enumerate}
  % \item second thing.
  \item third thing.
\end{enumerate}
```

Produces:

1.  first thing.
    1.  another thing
        1.  nesting.
    2.  don't forget to end the nests, though.
2.  third thing

### itemize

For un-numbered lists; uses bullet points. You can change the bullet points Latex uses by including the following command in your preface: \renewcommand{\labelitemi}{$\star$}. Replace \labelitemi with

`\labelitemii`, `\labelitemiii`, and `\labelitemiv`. Replace `$\star$` with basically any symbol you want (notice that `$\star$` is in math mode).

## decscription

Description is for giving short definitions or descriptions:

```
\begin{description}
  \item[Newton] 18th century physicist.
  \item[Descartes] 18th century philosopher.
\end{description}
```

Produces:

**Newton**
18th century physicist.

**Descartes**
18th century philosopher.

# Paper Writing

Latex can do everything you're used to your WYSIWYG editor being able to do. Some of these things, Latex does more simply and cleanly (but some things are less intuitive).

## Text Flow

Center with `\begin{center}` and `\end{center}`.

Adjust line spacing by including `\usepackage{setspace}`. Then, within your document, use `\doublespacing`, `\onehalfspacing`, and `\singlespacing`. All text following your command will be spaced as specified, until a new line-spacing command is issued.

Latex includes a nice block-quote environment: `\begin{quote}` and `\end{quote}` This environment is not automatically single-spaced.

## Organization

You might notice the wonderful, clean, and easy-to-follow organization of this document ;-).

To start off different parts of your document, use:

```
\chapter{Chapter Name}
```

```
\section{Section Name}
```

```
\subsection{Subsection Name}
```

```
\subsubsection{Sub-subsection Name}
```

```
\paragraph{Paragraph Name}
```

`\subparagraph{Sub-paragraph Name}`

Latex automatically numbers the sections for you (so if you add or remove a section, you don't have to re-number anything by hand).

Also notice that you don't have to begin and end the sections.

## Footnotes

Include a footnote with `\footnote{Content of footnote}`. [1]

## Font Sizes

| Name | Size (pt) |
|---|---|
| `\tiny` | 5 pt |
| `\scriptsize` | 7 pt |
| `\footnotesize` | 8 pt |
| `\small` | 9 pt |
| `\normalsize` | 10 pt |
| `\large` | 12 pt |
| `\Large` | 14 pt |
| `\LARGE` | 18 pt |
| `\huge` | 20 pt |
| `\Huge` | 24 pt |

You can modify font size in two ways: surround the text to be modified by curly brackets, or use the tag without curly brackets (in which case it is applied until you next include a text-modifying tag).

## Text Style

| Style | Latex Command |
|---|---|
| Bold | `\textbf{text}` |
| Underline | `\underline{text}` |

---

[1] Footnotes are automatically numbered, and appear at the bottom of the page.

They can also include

line breaks.

| Italic | `\textit{text}` |
| Slanty | `\textsl{text}` |
| Small Caps | `\textsc{text}` |
| Emphasized | `\emph{text}` |

The `\emph` tag is handy; it makes things italic, unless you're already writing in italics, in which case it makes the words not-italic. Good for emphasizing words in (e.g.) a quote written in a foreign language.

To switch between font families:

| Font Family | Latex Command |
| --- | --- |
| Roman (normal) font | `\textrm{text}` |
| Sans-Serif | `\textsf{text}` |
| Typewriter | `\texttt{text}` |

As with the font sizes, you can use these tags by surrounding the text to be modified by curly brackets. Alternatively, you can use the tags `\bf` (for bold), `\sl` (for slanty), `\em` (for emphasis), and `\sc` (for small caps), etc. These tags apply until you include a different font-modifying command.

## For More Information

If you don't know how to do something, as always, you are welcome to ask the MacLab tutors at the front desk (many of us know Latex). If you're using Latex at home and run into trouble, an internet search for "latex" plus the thing you want to know how to do is almost always fruitful.

Here are some personal favorite Latex-related websites:

**Latex: A document preparation system**
http://www.latex-project.org/

(complete with official lion mascot)

**Word Processors: Stupid and Inefficient**
http://ricardo.ecn.wfu.edu/~cottrell/wp.html

(particularly heavy-handed, but includes good information)

**The Tex showcase**
http://www.tug.org/texshowcase/

(some absurdly complicated, awesome functionality)